FISH POPULATION OF BUCKEYE LAKE AS DETERMINED BY TRAP NETS

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Reconnaissance surveys of fish populations in the public fishing waters of Ohio were begun in 1937 as a part of the newly inaugurated fish management program. These surveys were made by trap nets of the type commonly known as "fyke" nets. The work plan and itinerary were outlined by Dr. T. H. Langlois, Chief of the Section of Fish Management. Operations of nets were under the direct control of Mr. George Messerly, with a crew of experienced net men. The fish management agent of the region worked, was charged with the technical problems of the survey including the identification of fish and the location of the nets.

Most of this extensive work was done through the summer season. Since the movement of the fish was thought to be seasonal it was deemed wise to make a more intensive survey of one body of water including all seasons.

Buckeye Lake has been the subject of numerous aquatic surveys for a number of years and many records concerning its physical, chemical and biological history are available. In 1930, during a general biological survey of this Lake under the direction of Mr. E. L. Wickliff, fyke nets were operated for two weeks out of each month through July, August and September. In June, 1938, fyke nets were operated as a part of a general survey. For these and other reasons Buckeye Lake was chosen as the "test water" for the year around population study.

DESCRIPTION OF THE LAKE

Descriptions of Buckeye Lake have appeared in various reports and are possibly best summarized by Tressler, Tiffiany and Spencer (1940). The following corrections and additions may be made to their descriptions.

Figures derived from 1938 A.A.A. aerial maps and checked against U. S. geological survey topographic maps and personal observations indicate that Buckeye Lake had at that time a water area of approximately 3,800 acres. The Lake contained four islands of from five to forty acres each and a half dozen smaller ones, all of which together totaled 141 acres. The total shoreline measured 31.5 miles, of which 22.7 miles were of the mainland.

Between 1930 (Tressler et al.) and 1939 (during the current survey) two changes apparently occurred in the Lake. One of these was a silting in of the "deep portion" near Avondale, across from Honey Creek—a principal tributary. In 1930 the depth measured seven meters, in 1939 no depth over five meters could be found. The other change was an expansion of the aquatic meadows of the bays and eastern end.

Apparently much of the expansion occurred during the summer of 1934 (Roach and Wickliff, 1934), at which time low water combined with high temperatures was conducive to good plant growth. In 1939 the area of swamp and heavy vegetation exceeded 500 acres and made up nearly one-eighth of the Lake area. Most of the submerged vegetation was hornwork (*Ceratophyllum demersum*) and was seldom found in depths exceeding six feet.

EQUIPMENT AND PROCEDURE

The standard fyke net used consisted of a lead 100 yards long and eight feet deep, hearts (wings folded in) with a spread of forty feet, as set, and a depth of eight feet, a big tunnel (breast) tapering from eight feet, at the hearts and lead

to four feet at the body and a body four feet square and twelve feet long of two cars. The mesh of the lead was two inches square, of the hearts and breast one and one-half inches square and of the body and throats one inch square. The throat leading to the first car was twelve inches square and the one leading to the last car was eight inches square. The nets were tarred.

In all but two cases the nets were set in water eight to ten feet deep with their leads tied to shore and their body stretched at right angles to the shore. In January and February, however, in order to insure against freezing the floats in the ice cover, the lead ran from the "deep spot" at Avondale back to the body which was toward shore. The net during these months, was set in from ten to twelve feet of water.

Two nets were operated continuously from June 1 to October 5, 1939. One was set off the southwest point of Journal Island in the open water of the west end of the Lake. The other was set within the vegetation beds of the east end of the Lake between Edgewater Beach and Donaldsons Landing.

Beginning in November, 1939, one net only was operated and that for but one week in each month. This net was set off a point just east of the Avondale Beach where preliminary information led us to believe there was an intermingling of both "east end" and "west end" species. Treacherous ice conditions through most of March, 1940, made operations impossible until the very end of the month, so the results are included with those for April, 1940. The operations in January and February, 1940, were carried on through an ice cover of from eight to fifteen inches.

Through August and September, 1939, a roving net supplemented the two stationary nets. This net was set for a week at a time at the following points: North shore of Journal Island, Fillbricks Point, Big Spring Bay, Liebs Island, Island No. 3, Blue Goose Point, and Avondale. These sets were made to check the catches in a variety of habitats against the stationary net catches and to check against catches of the preliminary surveys of 1930 and 1938.

The east end net was lifted daily at 8 A. M., the west end net at 1 P. M. and the roving net was usually lifted in the middle of the afternoon. The Avondale net (winter and spring sets) was lifted at 8 A. M. daily.

The last car of the net was lifted and "hung" on the side of the boat with the throat above water level to prevent the escape of the fish and at the same time to allow sufficient water to cover the bottom of the car permitting free movement of the fish.

Each fish was removed from the car by dip net, identified, measured, and marked. Scales were taken and weights were obtained from a suitable sample of all the fish. Each fish was measured to the nearest quarter of an inch. When first caught each fish was fin clipped (the right pelvic on those caught in the west end and the left pelvic on those caught in the east end, including Avondale). When caught the second time the fish were strap tagged on the gill plate. On third, and subsequent recatches, record of the tag number was made.

ABUNDANCE AND DISTRIBUTION OF FISH

In some cases, particularly in smaller bodies of water, it is possible to estimate the total number of fish present by applying mathematical formulae employing the ratio of the number of fish caught to the rate of recatching. Although our recaught fish ranged from 0.9 to 7.8 percent of the total catch in various months, we do not attempt to make an estimate of the total population in Buckeye Lake at this time since our nets obviously fished such a small portion of the Lake and sampled such a small portion of the available habitats.

Figure 1 shows the number of fish caught per hour by our two stationary nets and the Avondale net.

Examination of this data shows that twenty-six species of fish were caught by these nets during the year. The maximum number of species taken any one month was seventeen. (June, west end; September, east end; December, Avondale.) The minimum recorded for any one month was ten. (October, east end; January, Avondale.) This qualitive distribution obviously does not correlate with the quantitative abundance, nor with the seasons.

Twenty-two species were taken by the west end net, twenty-one species by the east end net and nineteen by the Avondale net. Thus about the same number of species occupied the different sections of the Lake.

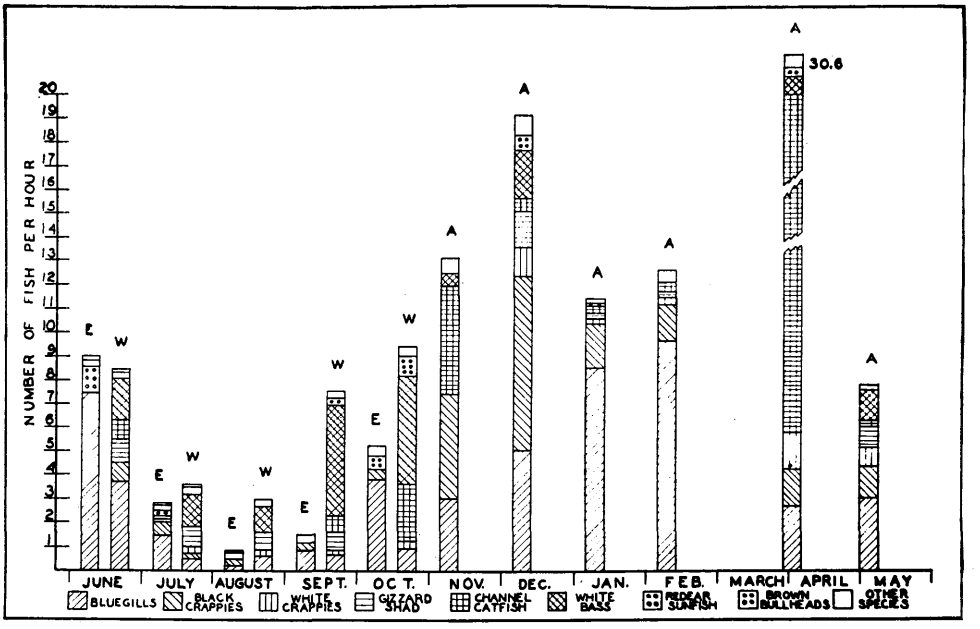

FIG. 1. Graph of fish catch by stationary and winter nets, showing average number of fish caught per hour through each month operated. (E, east end; W, west end; A, Avondale.)

Quantitative data show more correlations. The most noticeable of these is the decrease in catch per hour from June to August and a gradual rise from August to December. Under the heavy ice cover of January and February the catch dropped to about twelve fish per hour which, nevertheless, was several times greater than the mid-summer catch. The week following the ice break up the catch rose to an average of 38.0 fish per hour, of which 30.5 were channel catfish (*Ictalurus punctatus*). Spring catch decreased in 1940 to about eight fish per hour, a number corresponding to the number caught in the spring of 1939.

Bluegills (*Lepomis machrochirus*) were the dominant fish in the east end, catches ranging from 34 percent (August) to 83 percent (June) of the total number of fish taken. White bass (*Lepidema chrysops*) were the dominant fish in the west end catches (except in June when they were exceeded by bluegills) ranging from 26 percent of the total catch in June, to 62 percent in September.

The dominant species caught in the Avondale net from November, 1939, to May, 1940, varied. In November the dominants were black crappies (*Pomoxis nigro-maculatus*), making up 34 percent of the total catch, bluegills 25 percent and channel catfish 22 percent.

In December black crappies made up 43 percent, bluegills 31 percent and white bass 13 percent of the total number of fish caught.

In January bluegills totaled 75 percent and black crappies 15 percent of the total catch. This was almost duplicated by the February catch in which these two species made up 76 and 14 percent respectively of the total.

In March and April channel catfish made up 80 percent of the total catch. These were followed by white crappies, 6 percent, black crappies, 4 percent, and white bass, 2 percent.

Trap nets are thought to be selective as to species and numbers of fish caught. Fish with solitary habits or with a tendency toward cannibalism are not caught in as large numbers as are those of a more gregarious nature. The true ratio of fish species in a given body of water to the catch made by various types of nets needs yet to be worked out, although from some work I have done I do not believe the type of net used gives a picture of fish populations very dissimilar from the actual population. (Roach, 1940.)

However, if we consider the catch by these nets as roughly indicating comparative numbers we may say that bluegills are the dominant fish of Buckeye Lake. White bass are apparently the sub-dominants in the open portion of the Lake while black crappies fall into this position in the sections of abundant vegetation. White crappies (*Pomoxis annularis*) and brown bullheads (*Ameiurus n. nebulosis*) come in just one step lower as sub-dominants of the open water and vegetation sections respectively.

Channel catfish and largemouth black bass (*Huro salmoides*) are apparently adapted to both weedy and open situations although the bass tend toward the weedy portions and the catfish toward the more open areas.

Gizzard shad (*Dorosoma cepedianum*) were caught in all three nets each month but apparently preferred the more open situation.

The other species caught evidently have their own habitat niches, none of which are extensive enough to make them dominant species in Buckeye Lake. One species, the red-eared sunfish (*Lepomis microlophus*), caught in fair numbers in June and July by the east end net was not known in Buckeye Lake prior to 1934, at which time 57 breeders were stocked. During this survey 1,018 red-eared sunfish were taken so it seems reasonable to assume that the Lake has an environment suitable to their needs and that they may become a dominant species in time. This may be at the expense of some other species, possibly the bluegill.

Since data compiled from our stationary and winter nets indicate a considerable variation in the numbers and kinds of fish caught in a measured period of time, over different seasons and in different habitats, it seems apparent that little in the way of comparison can be made between the catches of 1930, 1938 and 1939–40 as far as actual number per hour is concerned. For example, nets set off Journal Island in July, 1930, caught 10.4 fish per hour; in June, 1938, 22.2 fish per hour; in June, 1939, 7.0 fish per hour. While it is evident that little comparison can be made between the quantity caught in the different years we believe it is safe to assume that there has been no appreciable decrease or increase in total numbers of fish over that period of time (1930 to 1939) since the variations that occur appear to be seasonal.

Figure 2 has been prepared to show the relative abundance of the species caught by the 1930 and 1938 preliminary survey nets and the 1939 roving net. Fish are graphed according to their percentage of the total catch.

The percentage of bluegills caught in July, 1930, compares favorably with the percentage caught in June of 1938 (60.8 and 58.0 percent respectively), while the percentage of bluegills caught in June of 1939 dropped to 41.3. This most certainly does not indicate a loss of bluegills in 1939 over 1930 or 1938, but it does show that June of 1939 was a slightly different month from June of 1938 or July of 1930.

This might be amplified by comparing the July, 1930, and June, 1939, percentages 60.8 and 41.3 respectively with the September, 1930, and September, 1939 percentages, which were 12.2 and 9.8 respectively. The difference between June and September percentages in the same year (e.g., 60.8 to 12.2) is noticeably more pronounced than the difference (e.g., 12.2 to 9.8) between the same months from 1930 to 1939.

Another example of this same situation was the catch taken at Journal Island. The percentage of white bass caught at Journal Island in September, 1930, was 72.0 and in September, 1939, 62.0. On the other hand, white bass in July, 1930, made up only 11.4 percent of the total fish caught as compared with 6.8 percent in June of 1938 and 26.0 percent in June, 1939.

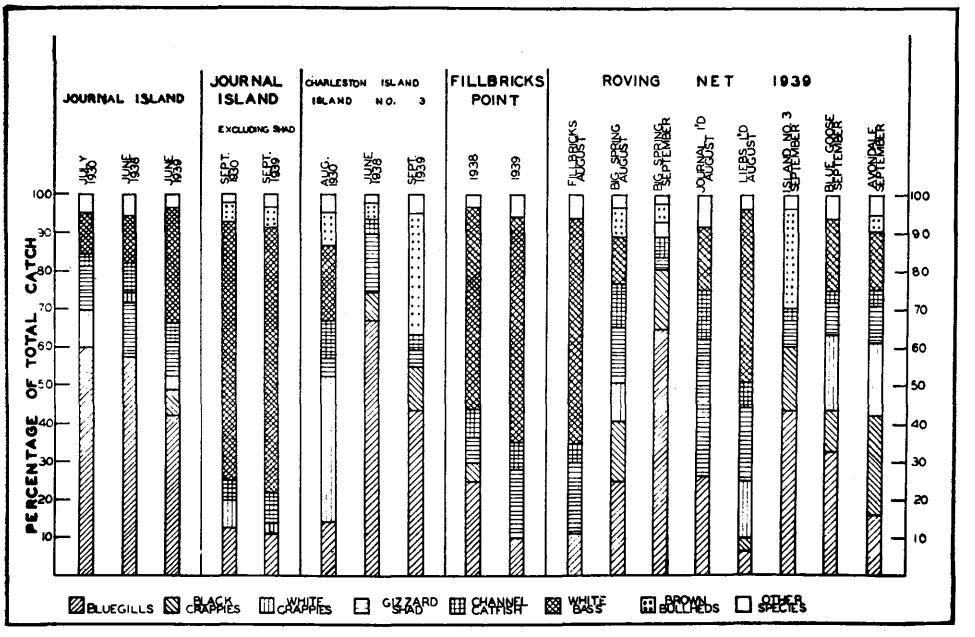

FIG. 2. Graph of fish catch in percentage of total number for 1930, 1938 and the roving net for 1939.

As has been indicated in an earlier paragraph, different environments also influence the percentages of the various species caught. For example, at Fillbricks Point (an open water situation) in August, 1939, only 9.7 percent of the fish caught were bluegills, whereas 61.3 percent were white bass and less than one percent was black crappies. At Big Spring Bay (a heavily vegetated area) one week later and still in August, 25.5 percent of the fish caught were bluegills, whereas 15.6 percent were black crappies and only 6.6 percent were white bass.

The only noticeable difference in the percentages of fish caught in 1939 as compared with 1930 occurred in the catch of black crappies which ran consistently higher in 1939. It is believed that these fish require a considerable amount of vegetation and clear water so the expansion of the vegetation area since 1930 might be an explanation.

GROWTH RECORDS

All fish were measured to the nearest quarter inch as they were caught. Since our stationary and Avondale nets were operated each month over a year we should

TABLE I

Buckeye Lake

Weighted Mean Length of All Species Caught in 1939 and 1940

Month	June		July		August		September		October		November	December	January	February	March and April	May
Location in Lake	East	West	East	West	East	West	East	West	East	West	Avondale	Avondale	Avondale	Avondale	Avondale	Avondale
Bluegill	6.3	6.7	6.4	6.8	6.0	6.9	6.4	7.1	6.5	7.2	7.2	7.3	7.4	7.0	6.9	6.9
Red-eared Sunfish	6.0	.....	6.1	.....	6.0	.....	6.4	.....	6.8	.....	6.1	7.1	7.1	7.2	6.2	.....
Pumpkinseed Sunfish	5.0	5.5	5.0	5.8	4.9	.....	5.1	.....	.....	.....	.....	.....	5.8	.....	.....	5.5
Hybrid Sunfish	6.0	6.0	.....	.....	.....	.....	5.2	.....	5.3	6.5	.....	.....	.....	.....	.....	.....
Green Sunfish	.....	.....	5.0	.....	5.5	.....	6.0	.....	.....	.....	.....	.....	.....	.....	.....	5.5
Long-eared Sunfish	.....	.....	6.2	.....	.....	.....	.....	.....	.....	.....	.....	6.5	.....	.....	.....	5.7
Rock Bass	.....	.....	.....	.....	.....	.....	.....	8.8	.....	.....	.....	.....	.....	.....	.....	.....
Black Crappie	7.4	7.9	7.5	7.9	7.2	7.3	7.9	7.8	8.1	7.5	7.4	8.2	7.5	8.0	6.3	7.4
White Crappie	.....	9.2	6.0	9.2	.....	8.3	9.2	9.3	.....	8.1	8.8	9.1	8.9	9.0	8.5	8.5
Largemouth Bass	11.8	17.2	7.8	19.4	8.1	16.4	8.0	14.1	8.3	.....	9.8	14.5	11.1	9.6	9.0	8.8
Smallmouth Bass	.....	12.2	.....	19.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
White Bass	.....	9.4	10.9	10.5	12.0	10.7	11.0	10.0	8.0	10.0	11.9	10.6	.....	.....	10.2	10.6
Chub Sucker	9.1	.....	8.3	.....	.....	.....	8.5	12.0	8.3	.....	9.0	.....	8.9	9.1	.....	9.3
Redhorse Sucker	11.9	.....	.....	.....	.....	.....	.....	17.1	.....	.....	.....	15.3	.....	.....	15.0	16.5
Common Sucker	.....	15.1	.....	14.8	.....	14.9	15.8	14.5	.....	13.1	14.7	7.5	.....	11.0	15.8	.....
Hog Sucker	.....	.....	.....	14.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Yellow Perch	.....	.....	.....	.....	.....	.....	.....	8.5	.....	.....	.....	.....	.....	.....	7.4	7.6
Channel Catfish	13.4	14.2	16.2	16.8	15.1	12.8	16.2	11.8	.....	11.7	10.5	10.9	10.1	10.6	9.4	9.4
Black Bullhead	10.0	10.1	10.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Brown Bullhead	9.8	10.6	10.1	9.5	9.9	11.4	10.0	10.8	10.0	10.7	10.1	10.4	9.9	9.7	9.1	9.8
Yellow Bullhead	8.2	.....	8.9	.....	8.5	.....	8.2	9.0	8.2	.....	8.8	6.8	.....	7.0	7.0	6.6
Golden Shiner	7.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.5	7.7
Gizzard Shad	11.0	10.8	12.7	10.9	10.8	10.8	10.9	10.9	13.1	10.5	10.8	10.9	11.0	11.0	11.0	11.4
Carp	24.3	22.0	19.0	21.2	23.3	24.2	29.0	22.6	.....	11.5	.....	15.8	.....	.....	23.8	.....
Quillback	.....	17.9	.....	.....	.....	17.4	.....	22.5	.....	20.5	.....	10.1	.....	.....	.....	.....
Walleye	.....	18.5	.....	.....	.....	19.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

be able to follow any variation in size of the same species by calculating their weighted mean length for each month. Comparisons of this type may also be made with the fish caught in a corresponding month and location during 1930 and 1938. I recognize that error of analysis might be introduced by this method, but I believe that examination of the distribution range should correct most of the error. Table I has been prepared to show the mean length of all species caught by our year around nets and Table II shows the mean lengths of the major species taken in 1930 and 1938.

Examination of these data indicates that the bluegills at Journal Island in July, 1930, averaged 7.38 inches in length but dropped to 6.77 in August of the same year. In June, 1938, at Journal Island the bluegills averaged but 6.4 inches in length. The decrease in average length of these fish from August to July in 1930 does not indicate a decrease in length of the fish caught but rather an influx of a young group that possibly, by August, had reached a size sufficient to be retained in the netting of the mesh size used in our traps.

TABLE II

WEIGHTED MEAN LENGTH OF MAJOR SPECIES

PLACE	1930 Journal Island	1930 Journal Island	1930 Charleston Island	1938 Fillbrick	1938 Journal Island	1938 Island No. 3
MONTH	July	August	September	June	June	June
Bluegills	7.38	6.77	7.66	6.5	6.4	5.8
Black Crappies	8.12	.....	.....	7.0	6.5	5.9
White Crappies	8.31	7.81	8.23	7.8	8.8	9.0
White Bass	10.48	10.08	11.62	8.3	9.1	.....
Channel Catfish	16.59	11.99	19.63	11.7	11.4	14.1
Brown Bullhead	11.58	10.66	11.60	.....	.....	.....
Gizzard Shad	.....	.....	.....	10.3	10.2	10.5
Carp	23.81	25.90	24.11	21.7	21.6	22.2

This is possibly better illustrated by the figures given in Table I. Bluegills from the east end net in June, 1939, averaged 6.3 inches, in July 6.4 inches and in August dropped to 6.0 inches (with an influx of small fish). However, in September they had again risen to 6.4 inches and by October, 1939, to 6.5 inches.

The 1939 catch of bluegills for the west end, on the other hand, indicated a steady increase in mean length. In June they averaged 6.7 inches, in July 6.8 inches, in August 6.9 inches, in September 7.1 inches, and in October 7.2 inches.

This difference might indicate that hatching and rearing conditions in the vegetated east end surpass those of the open west end and that this results in the east end producing unusual numbers of young which, however, would not make themselves felt in the west end until the population pressure of the east end became so strong as to cause a push resulting in a migration west.

The growth of white bass as shown by length frequencies and amplified by scale analyses, indicates that this fish lives but three years. It grows to about seven inches its first year, to between ten and eleven inches its second year and to about twelve and a half inches its third year. Most of the third-year group disappear during late fall, winter or early spring.

The variation or fluctuation of the mean length of other species from month to month is also noticeable. For example, the black crappies of the east end in June, 1939, averaged 7.4 inches, in July 7.5, in August 7.2, in September 7.9, and in October 8.1 inches.

It is generally considered by many fisheries biologists that the carrying capacity of fish in pounds per acre is fairly consistent over a period of years for the species the water contains. If the variations in average lengths of these fish is translated into average weights an explanation for the fluctuations might be had.

MANAGEMENT SUGGESTIONS AND SUMMARY

Trap nets of the fyke design were operated in Buckeye Lake for a year (June, 1939, to June, 1940). A gradual decrease in number of fish caught per net hour was noted from June to August and a gradual rise from September to December. Over ten fish were caught per net hour in January and February under a heavy ice sheet. This was over five times as many as were caught in August. Immediately after the ice thaw (late March and early April) over thirty-eight fish were caught per hour. The catch per hour in May, 1940, approached the June, 1939, catch. Bluegills were the most abundant fish, being caught in every net, every month, white bass, black crappies, white crappies, gizzard shad and channel cats were also numerous. Twenty-six species of fish were taken by our nets.

Distinct differences were noted in the catches of the net set in the open water of the west end as compared with the net operated in the vegetated east end. Bluegills and black crappies were dominants in the east end. White bass, white crappies and gizzard shad were the west end dominants.

Besides seasonal differences in our quantitative catches habitat, or environmental, differences were noted. A roving net was operated through August and September. The catch per hour with this net, set for a week at a time in different locations, varied from three to sixteen fish per net hour. The open water situations seemed to be more favorable for movement.

Nets of the same kind were operated in this Lake for three months in 1930 and on a preliminary survey for two weeks in 1938. Catch records in numbers of fish per hour show no differences that cannot be explained by seasonal or other local and temporary factors.

Catch records computed in percent of total for each species also indicate no material change within these years in ratio of species except that the increase in numbers of black crappies appears to be coincidental with the expansion of the aquatic meadows of the east end.

Since all fish caught by the nets were measured and marked, excellent growth records and changes in size groups are illustrated by the length frequencies.

It is apparent from the data offered that the length groups did not change materially between 1930 and 1939. At least differences were not greater than they were in the Lake at different spots in the same month during 1939.

Although no figures were presented in this paper relative to our shore seining, crappies, bluegills, and bass, young of the year, are always found in large numbers. Bass constitute up to forty-four percent of fish caught by seine, bluegills up to twenty percent and crappies up to fifteen percent at certain spots. Apparently spawning areas are sufficient.

As a result of these studies it is obvious that stocking does not materially effect the fish crop in the Lake. It is disheartening to buy 1,500 breeder channel catfish, truck them all the way from Lake Erie for a season's stocking when over 6,000 native channel cats were caught in one net in a six-day period with only one-tenth of one percent repeating after the fifth day and no repeats from this net taken in another net 100 yards away. It also seems folly to ship in two truck loads of hatchery bluegills when there are an average of 200 of them in each 100 feet of shoreline in many sections.

The numbers of white bass and crappies stocked in the past eight years have been negligible, yet all indications point to the fact that they have maintained their relative abundance and total numbers. In fact the black crappie has become

a dominant species with the development of a more suitable habitat. In 1934 fifty-seven red-eared sunfish, a species never before found in Buckeye Lake, was stocked in the Lake. Without additional stocking our nets indicate that there are now several thousand red-eared sunfish in Buckeye Lake.

In past years, sanctuaries for spawning activities were set aside to protect the breeder fish, yet more young of the year were observed in areas not included in sanctuaries. These areas could not be closed off because they fronted cottages, boat docks or swimming beaches.

Except for continuing an inventory check on supply and demand and mechanically controlling excess vegetation so more water will be available to fishermen, few suggestions for better fish management can be offered.

Nearly every species of fish in the Lake is of "catchable" kind. This fact plus the large size of the Lake makes it impractical to attempt to "balance" fish populations of the Lake by nets. Again, because of the Lake size, fertilizing would not be practical.

It is apparent that habitat "niches" are filled with adult fish, so additions of material such as gravel to increase spawning area defeats its own purpose in that only a certain number of fish can reach adulthood.

It also appears to be evident that fish removed by fishermen are quickly replaced from native stock coming on, therefore additional legal restrictions will only result in a decrease of fishermen pleasure and not in increased fish.

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